UTILITY PATENT APPLICATION TRANSMITTAL

Address to:	Attorney Docket No.	1554/1556 (USW 0464 PUS)
Box PATENT APPLICATION **Assistant Commissioner for Patents** **Washington, DC 20231**	*Inventor(s) or Application Identifier:*	BRUCE A. PHILLIPS ET AL

1. This application entitled **SYSTEM AND METHOD FOR INCREASING DISTRIBUTION DISTANCE OF XDSL TYPE SIGNALS** is:

   a. _X_ A new application under 37 C.F.R. §1.53(b).

   b. ___ A ___ continuation ___ divisional or ___ continuation-in-part application under 37 C.F.R. § 1.53(b) of prior application Serial No. ___/_____ filed on _____, entitled _____.

Application elements and other attached papers:

2. _X_ Specification (incl. Claims and Abstract) [Total Pages 13]

3. _X_ Drawings (___ informal _X_ formal) [Total Sheets 1]

4. _X_ Oath or Declaration

   a. _X_ Newly-executed

   b. ___ Copy from a prior application (37 C.F.R. § 1.63(d))

5. ___ Incorporation By Reference: The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Item 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

6. ___ This application is filed by fewer than all the inventors named in the prior application, 37 C.F.R. § 1.53(d)(4).

   a. ___ ***DELETE*** the following inventor(s) named in the prior nonprovisional application:

   _____

   _____

   b. ___ The inventor(s) to be deleted are set forth on a separate sheet attached hereto.

CERTIFICATION UNDER 37 C.F.R. § 1.10

I hereby certify that this UTILITY PATENT APPLICATION TRANSMITTAL and the documents referred to as attached therein are being deposited on the below date with the United States Postal Service in an envelope as "Express Mail Post Office to Addressee" addressed to: Box Patent Application, Assistant Commissioner for Patents, Washington, D.C. 20231.

Express Mail Label No. EE 430 894 161 US

Date of Deposit: December 1, 1998

BRENDA J. HUGHES
(Type or print name of person mailing paper)

Brenda J Hughes
(Signature of person mailing paper)

7. Preliminary Amendment:

a. ___ A Preliminary Amendment is attached.

b. ___ Cancel in this application original claims _____ of the prior application before calculating the filing fee.

c. ___ Please amend the specification by inserting before the first line the sentence:

"This is a

___ continuation

___ divisional

of copending application(s)

___ Serial number ___ /_____ filed on _____."

d. ___ A Petition to Suspend Prosecution For The Time Necessary to File An Amendment (New Application Filed Concurrently) is attached.

8. Small entity status:

a. ___ A small entity statement is attached.

b. ___ A small entity statement was filed in the prior nonprovisional application and such status is still proper and desired.

c. ___ Is no longer desired.

9. Fee Calculation:

FOR	NUMBER FILED	NUMBER EXTRA	RATE	CALCULATIONS
TOTAL CLAIMS (37 C F R § 1 16(c))	14 20 -	0	X 18.00	0.00
INDEPENDENT CLAIMS (37 C F R § 1 16(b))	3 -3 =	0	X 78.00	0.00
MULTIPLE DEPENDENT CLAIMS (if applicable) (37 C F R. §1.16(d))			260.00	0.00
			BASIC FEE (37 C F R § 1 16(a))	760.00
		Total of above Calculations =		760.00
Reduction by 50% for filing by small entity (Note 37 C.F.R. §§ 1 9, 1.27, 1.28)				
		Assignment Recordal Fee	40.00	40.00
			TOTAL =	800.00

10. ___ A check in the amount of $_____ is enclosed.

11. _X_ The Commissioner is hereby authorized to credit overpayments or charge the following fees (or any deficiency therein) to Deposit Account No. _21-0456_:

a. _x_ Fees required under 37 C.F.R. § 1.16.

b. _x_ Fees required under 37 C.F.R. § 1.17.

12. Maintenance of Copendency of Prior Application

___ A request for extension of time and the appropriate fee have been filed in the pending **prior** application (or are being filed in the prior application concurrently herewith) to extend the period for response until _____.

13. _X_ An Information Disclosure Statement (IDS) is attached, along with the following indicated attachments thereto:

a. _X_ Form PTO/SB/08 (_1_ sheet(s))

b. _X_ Copies of references cited

14. ___ Certified copy of priority document(s)

15. _X_ Return Receipt Postcard

16. ___ Other: _____

17. _X_ An Assignment of the invention to US WEST, INC.

a. _X_ is attached.

b. ___ was recorded on _____ at Reel _____, Frame _____.

18. The power of attorney in the prior application is to:

_____
Name of Attorney of Record Reg. No.

___ The power appears in the original papers in the prior application.

___ The power does not appear in the original papers, but was filed on _____.

___ A new power has been executed and is attached.

19. Correspondence Address: Please address all future communications to:

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Respectfully submitted,

BRUCE A. PHILLIPS ET AL

Date December 1, 1998

Name: RALPH E. SMITH
Registration No.: 35,474

_X_ Attorney or agent of record
___ Filed under Rule 34(a)

SYSTEM AND METHOD FOR INCREASING DISTRIBUTION DISTANCE OF XDSL TYPE SIGNALS

TECHNICAL FIELD

The present invention relates to an arrangement for improving transmission distances in a system using digital subscriber line (DSL) type signals to distribute video programming over public telephone line networks.

BACKGROUND ART

Generally, distribution of video signals has been carried out using a coaxial cable connected communication network. However, due to the high cost and minimal signal quality of such a distribution network, attempts have been made to provide an alternative approach to distributing video signals. For example, telephone lines have been suggested as a physical structure for implementing video signal distribution. However, systems using the public switched telephone network (PSTN) are often bandwidth limited, providing generally only still frame or video conferencing capabilities. In addition, because telephone system carriers only typically use the PSTN for connectivity between subscribers, the PSTN does not provide any capability for dynamic routing digitized video without the use of dedicated leased, wide bandwidth circuits. Telephone line based systems also fail to provide acceptable VCR type functional control over the distribution of video programming.

On the other hand, an enhanced public switched telephone network does provide the capability distributing video on demand to subscribers over the PSTN. In such an arrangement, a menu of video programming information is made accessible at a subscriber's premises. A subscriber may transmit ordering information via the PSTN to available independent video information providers.

Video programming can then be accessed and transmitted to the subscriber directly from a video information provider or through a central office (CO) serving the subscriber. The video information provider is suitably arranged to transmit coded digital video data over wideband PSTN connected to the CO. The video data may be buffered at the central office for transmission over a plain old telephone service (POTS) line to the subscriber. Subscribers may use either a standard telephone or a dedicated control device located at a television set to order the video programming.

The central office can be connected to the various subscribers for transmission of video data using an asymmetrical digital subscriber line (ADSL) system. In such an arrangement, multiple ADSL interface units would be deployed to perform multiplexing of digital video information with voice information to be transmitted to the subscriber. The ADSL units would also provide support for transmission of one or more reverse control channels from the subscriber to the central office. The ADSL interface units are typically located at the central office and the subscriber location and are operative to combine video information together with bidirectional signalling and POTS for transmission over an ordinary telephone wiring plant.

However, known ADSL type transmission systems have not proven to be fully satisfactory. When environmental interference situations arise, ADSL transmission is more sensitive than POTS. As transmission distances over copper wire pairs exceed 18,000 feet, the signal quality of ADSL signals becomes seriously degraded. Thus, a need exists for a video signal distribution system which overcomes the above-noted problems.

DISCLOSURE OF INVENTION

Therefore, it is an object of the present invention to provide a system and method for distributing digitized video signals which overcomes the limitations on system flexibility and distribution range found in prior proposals.

It is another object of the present invention to provide a system and method for distributing DSL type signals which overcomes the limited distribution range in cost effective manner.

In accordance with these and other objects, the present invention provides a system for distributing digital subscriber line (XDSL) signals to end users over a telephone wiring plant having a central office for receiving video signals from a video source. The central office includes a first XDSL transmission unit for transmitting the received video signals on a twisted pair copper cable along with other telephony and digital data signals, and for receiving any data signals transmitted from end users. At least one end user location includes a second XDSL transmission unit for receiving video signals from the twisted pair copper cable, and for transmitting other data signals back to the central office. A regenerator is connected to the twisted pair copper cable and located a predetermined distance from the central office. The regenerator includes a receiver for receiving XDSL signals transmitted on the twisted pair copper cable from either the central office or the end user, a decoder for decoding the payload of a received XDSL signal into base data, an encoder for repackaging and encoding the base data into a desired protocol format, and a line driver for retransmitting the encoded signal onto the twisted pair copper cable for distribution to the original destination. In accordance with the present invention, the predetermined distance for the location of the repeater corresponds to a point on the twisted pair cable where the signal-to-noise ratio of a transmitted XDSL signal reaches a threshold of minimum acceptable signal quality.

In accordance with other features, the central office can transmit XDSL signals using an asynchronous transfer mode (ATM) protocol, and the regenerator encoder would be arranged to selectively repackage the base data into either the ATM protocol format or a direct transmission protocol format depending on the protocol requirements of the destination terminal. The XDSL signals are preferably in the form of very-high-rate digital subscriber line (VDSL) type signals, or asynchronous digital subscriber line (ADSL) type signals.

In accordance with another aspect of the present invention, a method is provided for distributing digital subscriber line (XDSL) signals to end users over a telephone wiring plant including receiving video signals at a central office from a video source, transmitting the received video signals on a twisted pair copper cable along with other telephony and digital data signals as an XDSL type signal to a terminal located at an end user site, and receiving data signals on the twisted pair copper cable at the central office from an end user terminal, and coupling a signal regenerator unit to the twisted pair copper cable at a distance from the central office corresponding to a point on the twisted pair cable where the signal-to-noise ratio of a transmitted XDSL signal reaches a threshold of minimum acceptable signal quality. The transmitted XDSL signals are received at the regenerator, and decoded into base data. The base data is repackaged and encoded into an XDSL signal having a desired protocol format, and retransmitted to the original destination terminal.

In accordance with other features, the regenerated signals can be transmitted using either a fixed rate or a variable rate of transmission.

The above objects and other objects, features, and advantages of the present invention are readily apparent from the following detailed description of the best mode for carrying out the invention when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIGURE 1 is a block diagram of a XDSL distribution system incorporating a regenerator in accordance with the present invention; and

FIGURE 2 is a flow chart illustrating overall system operation in accordance with the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring to Figure 1, an XDSL signal distribution system 10 is shown in accordance with the present invention. It is noted for purposes of understanding the present invention, the term XDSL is used as a broad label for identifying a number of different types of digital subscriber line (DSL) signal formats, such as rate adaptive DSL (RADSL), ADSL, high density DSL (HDSL), and very-high-data-rate density DSL (VDSL). The present invention as described below can be suitably adapted for anyone of these formats.

As shown in Figure 1, a video source 12 generates suitable video signals 14 for distribution to one or more customer sites 16. More specifically, the video signals are initially transmitted to a XDSL transmission unit (XTU_{co}) located at a central office location 18. The XTU_{co} then retransmits the signals on a distribution line formed from a fiber optic cable 20, and a twisted pair copper cable 22. The XTU_{co} includes a suitable host digital terminal (HDT) 24 and a digital subscriber line access multiplexer (DSLAM) 26 for combining telephony and digital data signals with the video signals on the twisted pair copper cable 22 as analog signals.

The signals transmitted from XTU_{co} 18 are preferably sent using an asynchronous transfer mode (ATM) protocol. Such a protocol requires ATM

framing of the signals to include a timing signal used by a receiving unit decoder to decode the signal payload.

The transmitted signals are ultimately received at one or more XTU_{cust} terminals 28 located at the respective customer sites 16. The XTU_{cust} terminals include suitable demultiplexers and decoders for separating the telephony, data, and video signals for output at suitable customer equipment such as a telephone, modem, and television. The XTU_{cust} terminal further includes multiplexers and coding arrangements which allow signals to be transmitted back to XTU_{co} 18. While the same twisted pair and fiber optic cables are used for transmission of signals in both directions, the return path has been separately shown in Figure 1 as line 30.

In accordance with the present invention, in order to extend the otherwise limited distribution range of XDSL encoded signals, a regenerator unit 32 is located at predetermined distances on the distribution line. The ATM layer transported on the distribution line will be repackaged and retransmitted at the regenerator to insure the data payload is valid. The predetermined location of a regenerator unit is calculated based on the effective loss of signal as a result of such factors as wire gauge, temperature, and distance, such that the regenerator unit will be located at a distance corresponding to a point where the calculated S/N ratio reaches a threshold of minimum acceptable signal quality. In an exemplary embodiment, the S/N ratio threshold is 18.5.

Regenerator unit 32 includes a receiver 34 for receiving signals from XTU_{co} 18, a decoder 36 for analog-to-digital conversion and decoding of the payload of the received signals into base digital data, and a buffer 38 for temporarily storing the base data. Receiver 34 includes a suitable time generator for extracting the timing of the incoming signals when an ATM protocol is used. An encoder 40 then reforms or repackages the data from buffer 38 into XDSL line signals, and a line driver retransmits the encoded signals onto the distribution line.

A similarly arranged receiver 42, decoder 44, buffer 46, encoder 48, and line driver 50 are provided for regenerating signals transmitted on line 30 from an XTU_{cust} 28 to XTU_{co} 18.

In further accordance with the present invention, two potential retransmission methods are employed by the regenerator unit. The first method provides for retransmission of signals with ATM layer processing, as the physical layer protocol may require. The other method provides for selective direct retransmission of signal from XTU_{co} 18 to XTU_{cust} 28 via the regenerator unit 32 for protocols which do not require ATM layer processing. Thus, decoding of the received signals into base data allows regenerator unit 32 to advantageously reform signal payloads as needed to comport with existing protocol layers. In addition, buffering of the base data allows the transmission rate to be either fixed or variable at both connections from the regenerator unit to XTU_{co} 18 and XTU_{cust} 28 to optimize data through-put rate or reach distance between XTU_{co} 18 and XTU_{cust} 28.

Referring now to Figure 2, a flowchart illustrates the overall operation of the regeneration unit 32. As denoted at block 100, XDSL signals transmitted from either XTU_{co} 18 or XTU_{cust} are received by receivers 34 or 42. The received signal payload is subsequently decoded into a base data level at block 102, and temporarily stored in the appropriate buffer at block 104. At block 106, a decision is made as to whether the destination of the signal requires ATM layer processing. If so, the payload base data is retrieved from the buffer and reframed or repackaged with the appropriate ATM framing including the necessary loop timing at block 108. If ATM layer processing required, the payload base data is retrieved from the buffer and packaged for direct retransmission at block 110.

As denoted at block 112, once the payload has been repackaged, the signal is encoded for transmission. At block 114, the encoded signal is transmitted

on the distribution line using a suitable line driver. As noted above, the rate of transmission can be fixed or variable as part of a through-put optimization process.

Thus, the present invention provides a system and arrangement for distributing XDSL type signals on twisted pair copper telephone cable which effectively extends the range or reach of the signals without moving a distribution hub/central office deeper into the network. In addition, decoding the payload of the XDSL signals into digital base data as part of the regenerator processing allows the repackaging of the regenerated XDSL signal in to a desired protocol format.

While the best mode for carrying out the invention has been described in detail, those familiar with the art to which this invention relates will recognize various alternative designs and embodiments for practicing the invention as defined by the following claims.

What Is Claimed Is:

1. A system for distributing digital subscriber line (XDSL) signals to end users over a telephone wiring plant comprising:

a central office for receiving video signals from a video source, the central office including a first XDSL transmission unit for transmitting the received video signals on a twisted pair copper cable along with other telephony and digital data signals, and receiving data signals from end users;

at least one end user location having a second XDSL transmission unit for receiving video signals from the twisted pair copper cable and transmitting data signals to the central office; and

a regenerator connected to the twisted pair copper cable and located a predetermined distance from the central office, the regenerator comprising:

a receiver for receiving XDSL signals transmitted on the twisted pair copper cable from either the central office or the end user;

a decoder for decoding the payload of a received XDSL signal into base data;

an encoder for repackaging and encoding the base data into a desired protocol format; and

a line driver for retransmitting the encoded signal onto the twisted pair copper cable for distribution to the original destination, wherein the predetermined distance for the location of the repeater corresponds to a point on the twisted pair cable where the signal-to-noise ratio of a transmitted XDSL signal reaches a threshold of minimum acceptable signal quality.

2. The system of claim 1 wherein the central office transmits XDSL signal using an asynchronous transfer mode (ATM) protocol, and the

regenerator encoder is arranged to selectively repackage the base data into either the ATM protocol format or a direct transmission protocol format depending on the protocol requirements of the destination terminal.

3. The system of claim 1 wherein the XDSL signals comprise very-high-rate digital subscriber line (VDSL) type signals.

4. The system of claim 1 wherein the XDSL signals comprise asynchronous digital subscriber line (ADSL) type signals.

5. The system of claim 1 wherein the line driver comprises a variable rate line driver.

6. The system of claim 1 wherein the line driver comprises a fixed rate line driver.

7. A method for distributing digital subscriber line (XDSL) signals to end users over a telephone wiring plant comprising:

receiving video signals at a central office from a video source;

transmitting the received video signals on a twisted pair copper cable along with other telephony and digital data signals as an XDSL type signal to a terminal located at an end user site, and receiving data signals on the twisted pair copper cable at the central office from an end user terminal;

coupling a signal regenerator unit to the twisted pair copper cable at a distance from the central office corresponding to a point on the twisted pair cable where the signal-to-noise ratio of a transmitted XDSL signal reaches a threshold of minimum acceptable signal quality;

receiving transmitted XDSL signals at the regenerator, and decoding the received signals into base data;

repackaging and encoding the base data into an XDSL signal having a desired protocol format; and

retransmitting the XDSL signal to the original destination terminal.

8. The method of claim 7 further comprising transmitting XDSL signals from the central office transmits using an asynchronous transfer mode (ATM) protocol, and selectively repackaging the base data into either the ATM protocol format or a direct transmission protocol format depending on the protocol requirements of the destination terminal.

9. The method of claim 7 further comprising transmitting the received video signals as very-high-rate digital subscriber line (VDSL) type signals.

10. The method of claim 7 further comprising transmitting the received video signals as asynchronous digital subscriber line (ADSL) type signals.

11. The method of claim 7 further comprising retransmitting the XDSL signals from the regenerator with a variable data rate.

12. The method of claim 7 further comprising retransmitting the XDSL signals from the regenerator with a fixed data rate.

13. A regenerator for use in a digital subscriber line (XDSL) signal type signal distribution system, the distribution system including a central office for transmitting video signals on a twisted pair copper cable along with other

telephony and digital data signals to at least one end user location, the regenerator comprising:

a receiver for receiving XDSL signals transmitted on the twisted pair copper cable from either the central office or the end user;

a decoder for decoding the payload of a received XDSL signal into base data;

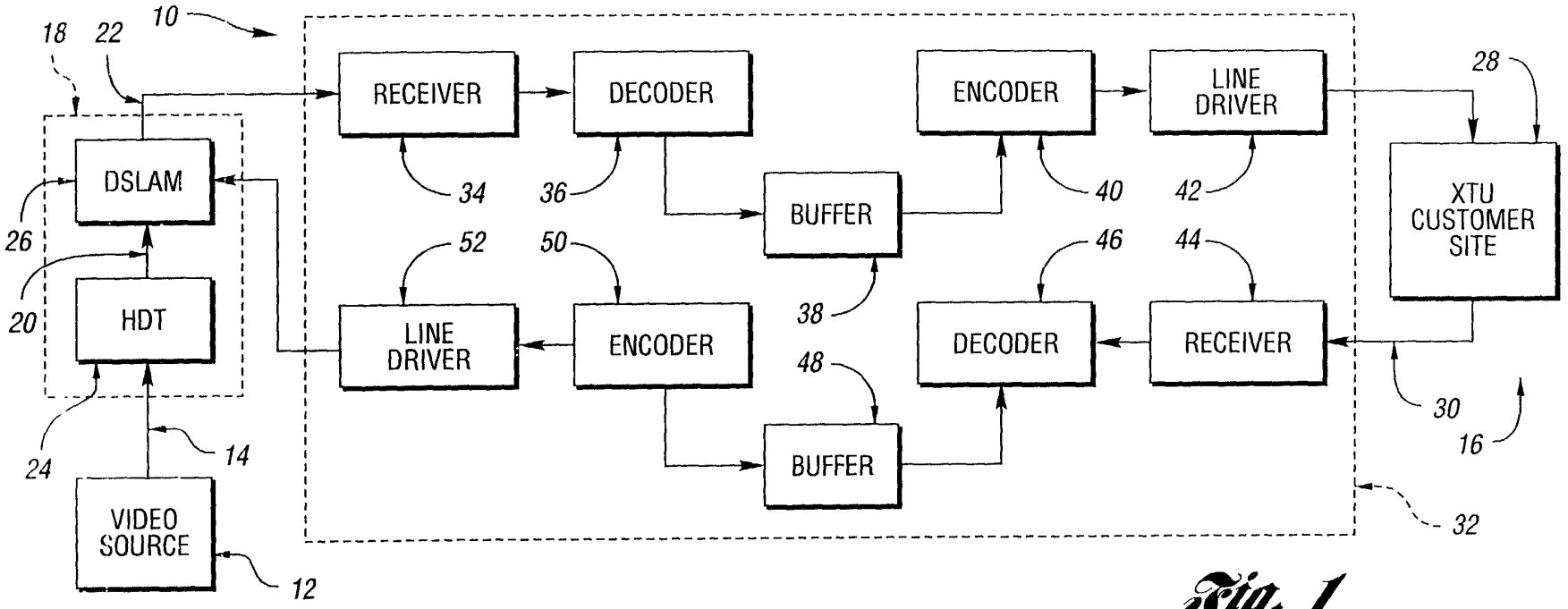
an encoder for repackaging and encoding the base data into a desired protocol format; and

a line driver for retransmitting the encoded signal onto the twisted pair copper cable for distribution to the original destination, wherein the predetermined distance for the location of the repeater corresponds to a point on the twisted pair cable where the signal-to-noise ratio of a transmitted XDSL signal reaches a threshold of minimum acceptable signal quality.

14. The regenerator of claim 13 wherein the receiver, decoder and encoder comprise a very-high-rate digital subscriber line (VDSL) type receiver, decoder and encoder.

Abstract

An XDSL signal distribution system is provided having a regenerator unit located a predetermined distance from a central office XTU unit for extending the distribution reach of the system. The regenerator is arranged to decode the payload of transmitted XDSL signals into base digital data before repackaging and regeneration onto a twisted pair copper cable. This allows the regenerator to selectively reformat the XDSL signals into a desired protocol format suitable for either an ATM protocol layer, or direct transmission. In addition, the regenerator can retransmit the XDSL signals at a fixed or variable transmission rate to optimize data through-put or system reach.


10
18
22
RECEIVER
DECODER
ENCODER
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DSLAM
26
34
36
BUFFER
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42
XTU CUSTOMER SITE
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44
HDT
LINE DRIVER
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38
DECODER
RECEIVER
48
30
16
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14
BUFFER
VIDEO SOURCE
12
32

Fig. 1

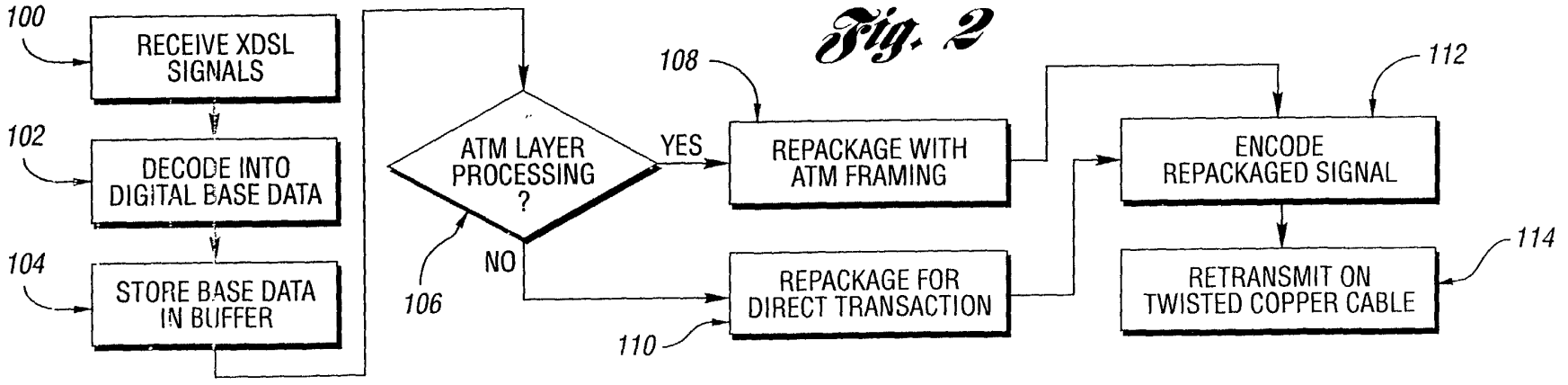
100
RECEIVE XDSL SIGNALS
102
DECODE INTO DIGITAL BASE DATA
104
STORE BASE DATA IN BUFFER
ATM LAYER PROCESSING ?
106
YES
NO
108
REPACKAGE WITH ATM FRAMING
REPACKAGE FOR DIRECT TRANSACTION
110
112
ENCODE REPACKAGED SIGNAL
RETRANSMIT ON TWISTED COPPER CABLE
114

Fig. 2

DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY

Atty. Docket No. 1554/1556 (USW 0464 PUS)
First Named Inventor Bruce A. Phillips

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

SYSTEM AND METHOD FOR INCREASING DISTRIBUTION DISTANCE OF XDSL TYPE SIGNALS

the specification of which:

[x] is attached hereto; or
[ ] was filed on (MM/DD/YYYY) _____ as U.S. Application Number or PCT International Application Number _____, and was amended on (MM/DD/YYYY) ____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below, and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	*Country*	*Foreign Priority Date (MM/DD/YYYY)*	*Priority Not Claimed*	*Certified Copy Attached? (Yes/No)*

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

Application Number(s)	*Filing Date (MM/DD/YYYY)*

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

Application Number(s)	*Filing Date (MM/DD/YYYY)*	*Status: Patented, Pending, Abandoned*

Declaration for Patent Application (cont'd.) Atty. Docket No. 1554/1556 (USW 0464 PUS)

I hereby appoint the following registered practitioners to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

Ernie L. Brooks, Reg. No. 26,260; James A. Kushman, Reg. No. 25,634; David R. Syrowik, Reg. No. 27,956; Mark A. Cantor, Reg. No. 30,614; Ralph M. Burton, Reg. No. 17,748; Robert C J. Tuttle, Reg. No 27,962; Earl J. LaFontaine, Reg. No. 30,766; Ronald M. Nabozny, Reg. No. 28,648; Thomas A. Lewry, Reg. No. 30,770; John E. Nemazi, Reg. No. 30,876; Kevin J. Heinl, Reg. No. 29,805; William G. Abbatt, Reg. No. 31,936; Donald J. Harrington, Reg. No. 17,427; Paul M. Schwartz, Reg. No. 33,278; Timothy G. Newman, Reg. No. 34,228; Frederick M. Ritchie, Reg. No. 18,669; Robert C. Brandenburg, Reg. No. 29,048; A. Frank Duke, Reg. No. 20,937; John M. Halan, Reg. No. 35,534; Jeffrey M. Szuma, Reg. No. 35,700; James R. Ignatowski, Reg. No. 26,741; Frank A. Angileri, Reg. No. 36,733; William G. Conger, Reg. No. 31,209; Rhonda L. McCoy-Pfau, Reg. No. 37,887; Sangeeta G. Shah, Reg No. 38,614; Christopher W. Quinn, Reg. No. 38,274; Robert C. Jones, Reg No. 35,209; David S. Bir, Reg. No. 38,383; Konstantine J. Diamond, Reg. No. 39,657; James N. Kallis, Reg. No 41,102; Hugo A. Delevie, Reg. No. 32,688; Ralph E. Smith, Reg. No. 35,474; Michael S. Brodbine, Reg. No. 38,392; Jeremy J. Curcuri, Reg. No. 42,454; Mark D. Chuey, Reg. No. 42,415; and John J. Ignatowski, Reg. No. 36,555; Pete N. Kiousis, Reg. No. 41,117; Gigette M. Bejin, Reg. No P-44,027; Stephanie M. Mansfield, Reg. No. P-43,773; Mark E. Stuenkel, Reg. No. P-44,364; Peter J. Kinsella, Reg. No. 39,729; Mark A. Thomas, Reg. No. 37,953.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Inventor's signature Bruce A. Phillips Date 11-24-98

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Full Name of Seventh Joint Inventor **DONALD L. BRODIGAN**

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